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CLADDING SYSTEM

FIELD OF THE INVENTION

The field of the present invention relates to claddings systems for buildings or structures, particularly a cladding system relating to sealing a building or structure optionally with an in place continuous weatherproof membrane.

BACKGROUND OF THE INVENTION

For the weather proofing of a building, in particular the roof (but also applicable to side wall on other surface cladding), there are many systems available.

For roofs these extend to tiles and other discreet forms of layered roofing protection such as long run steel and corrugated roofing. For walls there are similar type cladding systems of discreet tiles or sections to cover and seal the wall. Another class of cladding systems both for roofs and walls is to utilise a semi-continuous membrane which is laid, coated or otherwise applied to the surface to be sealed and which may be in-place sealed to form a continuous membrane, e.g. sheets which are laid down and then sealed to each other at their periphery.

Methods of doing this presently involve the laying of such a membrane onto a substrate and attaching the membrane directly to the substrate by gluing or adhesive means. This therefore requires the application or adhesive or adherent means to the substrate and then subsequent application of the cladding sheet or material and/or any fixings to hold the cladding in place while the adherent or adhesive cures. This is particularly time consuming and involved, especially when on the side of a building, for example. There are also roofing systems that relay upon ballasted means to retain the roofing or cladding system in place. For example the laying down of a semi-continuous membrane and rather than adhering this to the base structure a grit or stone course material is laid over the

top and by the weight of this material the cladding is retained on the roof structure. Over time, however, such ballasted roofings can break down the membrane on which they lie. Such cladding systems thus whilst easy to lay, have an ongoing maintenance issue.

The further short coming of such present membrane cladding systems for weather proofing buildings and/or structures is their exposure to the elements and particularly ultra violet light. Such constant exposure to ultra violet light ultimately breaks down the majority of materials that have been used to date for such membrane cladding systems. It is also desirable to have a material which is resistant to the elements which can also be formed into position whilst still imparting a membrane like structure or coating.

An advantage therefore is to be gained by the use of material which is long term stable (i.e. 50 years or more) in the presence of ultra violet light in such a building structure cladding system. A further advantage is to be gained when such a cladding membrane is available for simple and fast, fastening and installation.

It is therefore an object of the present invention to provide a membrane cladding system for buildings, structures or the like which at least goes some way to overcoming at least some of the above disadvantages or at least goes some way to meeting the above desiderata and/or provides the public with a useful choice.

BRIEF DESCRIPTION OF THE INVENTION

In a first aspect the present invention may be said to broadly consist in a **building cladding** to be applied to a cladding substrate, said building cladding having a cladding material of fusible material which is at least in part attached or attachable by fusing to fastenings, said fastenings at least penetrating said cladding substrate,

wherein by further fusion to itself said cladding material forms a generally continuous cladding membrane over said cladding substrate.

Preferably said fusion is by fusible welding such as thermal or ultrasonic welding.

Preferably said fastenings have a layer of material fusible to said cladding material on that surface which presents to said cladding material.

Preferably said fusible material is a thermoplastic polyurethane.

Preferably said fastenings sit on top of said cladding and have said material fusible on their underside.

Preferably said fastenings sit intermediate said cladding material and said cladding substrate and have said material fusible on their top side.

Preferably said fastenings may sit within the structure of said cladding material, and have said material fusible on either their top and/or underside.

Preferably said fastenings may join, by fusible welding, adjacent sheets of cladding membrane.

Preferably said fastenings are of an elongate strip form.

Preferably said fastenings are of a discrete or washer like form.

Preferably said fastenings are of a rigid core with said fusible material coated there on.

Preferably said fastenings are a singular material of fusibly weldable nature.

Preferably said fastenings are penetratively fixed to at least said cladding substrate.

Preferably A building cladding as claimed in any one of claims 1 to 13 wherein said fastenings have provision for or can be associated with a penetrative fastener.

In a further aspect the present invention consists in a **cladding membrane** for a building structure said cladding membrane having at least a first layer with an external major surface of a highly ultraviolet stable stabilised, heat or sonic fusible, thermoplastic polyurethane, said cladding membrane fusible to itself to form at least an in part continuous weather proof cladding for said building structure.

Preferably said thermoplastic polyurethane has a secondary lamination to its internal major surface of one of the following:

i) Acrylonitrile – Butadiene – Styrene ("ABS"), or
ii) Aluminium foil/or sheet, or
iii) Aluminium mesh (or expandable aluminium), or
iv) Polypropylene ("PP"), or
v) Polycarbonate ("PC"), or
vi) Polyethylene ("PE"), or
vii) Thermoplastic polyurethane ("TPU"), or
viii) Natural fibre or cloth (e.g. jute or cotton), or
ix) Man made fibre (e.g. PP, polyethylene tetraphthalate ("PET"), or PE, in woven, non-woven, melt blown or filament form)
x) a plastics material, or
xi) a metal material.

Preferably said cladding membrane may have a further tertiary lamination to the underside of said secondary lamination of one of the following:

i) Thermoplastic polyurethane ("TPU"), or
ii) Acrylonitrile – Butadiene – Styrene ("ABS"), or
iii) Polypropylene ("PP"), or
iv) Polycarbonate ("PC"), or
v) Polyethylene ("PE"), or
vi) Polyethylene tetraphthalate ("PET"), or
vii) Ethylene Propylene Diene Monomer ("EPDM"), or
viii) Ethyl Vinyl Acetate ("EVA"), or
ix) Thermoplastic Rubber ("TPR")
x) a plastics material, or
xi) a metallic material.

Preferably there is a secondary and tertiary layer, the secondary layer lies between said first layer and said tertiary layer.

Preferably said secondary layer is encapsulated by said first and tertiary layers.

Preferably there is a fourth layer on the outside major surface of said tertiary layer which consists of an adhesive or adherable material.

In another aspect the present invention consists in a **method of providing at least part of a building envelope** with a weatherproof membrane, said method comprising or including the steps of,

i) providing an array of fixing members, attaching into part of the structure of said building envelope,

ii) prior to and/or subsequent to the attaching of at least some, if not all, of said array of fixing members, locating a membrane onto said structure, to define a weather resistant surface, whether or not said membrane is of a single composition, fabricated as a laminate structure or otherwise, and

selectively fusing material(s) of said membrane and material(s), at least in part, of said array of fixing members to each other by application, in situ, of ultrasound or heat or other method causing, at least in part, fusion of said membrane to some or all of said fixing members.

In another aspect the present invention consists in a **method of providing at least part of a weather resistant building envelope** said method comprising or including, in any suitable order,

providing an array of fixing members (composite or otherwise), attaching into part of the structure of a building envelope,

locating a membrane suitable to make part of said structure weather resistant, and fusing materials(s) of both,

(i) said membrane, and

(ii) part of at least some of said fixing members,

to each or one another by application, in situ, or ultrasound, or heat and/or other energy input.

Preferably said membrane may be fused to itself to form a join or fold to itself or adjacent membranes.

Preferably wherein there is also an array of adjacent sheets of material joined by fusible welding.

Preferably said membrane includes at least in part a thermoplastic polyurethane.

Preferably said membrane is not itself coated, but it is rendered resistant to ultraviolet radiation if required.

Preferably the array of fixing members is pre-attached to said structure of the envelope prior to over lying thereof with the membrane and subsequent fusing said fixing members to said membrane.

Preferably the attaching of the array of fixing members involves a penetration of the already laid membrane and subsequent attaching to said structure, and fusible welding of said fixing members to said membrane.

In yet a further aspect the present invention consist in a **fixing member** to provide an array for fastening a cladding membrane to a cladding substrate which comprises or includes provision of a member of substantially planar form with at least a layer of thermoplastic polyurethane on that surface to be fusibly associated with said cladding membrane, having at least one penetrative fastening protruding from its under side for penetrative association with a building substrate or structure.

Preferably said fixing member is a discrete "washer style" planar forms with one penetrative fastening there on.

Preferably said fixing member is circular in plan form.

Preferably said fixing member is of a many sided polygonal shape in plan form.

Preferably said fixing members are elongate "strip style" planar forms having a multitude of penetrative fastenings arranged along their length.

Preferably there is a ridge running along the length of said elongate planar form to form a T joint, whether inverted or otherwise, between abutting sheets of cladding membrane.

Preferably in cross-section said fixing member may have a cap like portion extending outwards from an upright to provide a cap that abutting sheets of said cladding membrane may at least in part lie under to form a join and/or fastening down of said cladding membrane.

Preferably said cap may be one sided to receive only one sheet of said cladding membrane.

Preferably said cap is two sided to receive two sheets, one either side of said upright, of said cladding membrane.

Preferably said fixing members may lie on top of said laid cladding membrane, penetrating said membrane and fastening down to said building substrate.

Preferably said fixing member may lie underneath said cladding membrane before said membrane is laid.

Preferably said fixing member is fastened in place (either above or below said cladding membrane) and said cladding membrane is laid, the fixing member and membrane are at least in part fusibly welded to each other to at least fasten said membrane down.

Preferably said fixing member is above said cladding membrane, said fusible welding also seals at least in part underside periphery of said fixing member to said cladding membrane.

Preferably said fixing member has at least in part a lining of fusibly weldable material on its under side when fastening said cladding membrane from above, to fusibly weld to the fusibly weldable upper layer of the cladding membrane.

Preferably said fixing member has at least in part a lining of fusibly weldable material on its upper side when fastening said cladding membrane from below, to fusibly weld to the fusibly weldable material lower layer of the cladding member.

Preferably said fusibly weldable material on said fixing members is a thermoplastic polyurethane.

Preferably said fusibly weldable material on said cladding membrane is a thermoplastic polyurethane.

Preferably said fixing members have a core of material, with said thermoplastic polyurethane laminated there over.

Preferably said fixing member may consist only of said thermoplastic polyurethane.

Preferably said penetrative fastening is fixed to or passes through said core.

Preferably said fixing member presents a sealed or sealable upper surface.

Preferably a further sealing member may be added to or over said fixing member so that when said fixing member is fusibly welded to said cladding membrane a weather and element proof upper surface is presented.

Preferably said member may be used in corners, on slopes and/or for cladding ridgelines, changes in shape and/or curvature to fasten and/or seal abutting or continuous cladding membranes.

In yet a further aspect the present invention consists in a **structure** rendered at least in part waterproof by the use of a method in accordance with the present invention.

In yet a further aspect still the present invention consists in, **in combination**, a plurality of said fixing members and a membrane compatible therewith so as to be complimentary therewith if used in a method in accordance with the present invention.

In yet a further aspect still the present invention consists in a **roof, wall or other region of a building envelope** rendered weather resistant by use of a membrane of any of the kinds herein exemplified where such membrane is held in place by localised association with each of an array of fixing members,

wherein said association optionally includes moulding or fusing of a thermoplastic polyurethane with a complimentary material forming at least part of each said fixing members.

In yet a further aspect still the present invention consists in a **fixing member** suitable for use in a method in accordance with the present invention.

In yet a further aspect still the present invention consists in a **building** with a weatherproof membrane applied to the structure of the building, the weatherproof membrane having been applied by a method as claimed in any one of claims 21 to 28 with reference to any one or more of the accompanying drawings.

In yet a further aspect still the present invention consists in, **in combination**, multiple penetrative fasteners at least in part attached through or on a fixing member wherein said fasteners are fastened or fastenable to a building structure, and a membrane to clad said building structure whereby the fixing members, fastened or fastenable to the building structure, as in array can support the membrane by fusing between said fixing members and said membrane to retain said membrane to said building structure to provide a weatherproof membrane for said building structure.

In yet a further aspect still the present invention consists in a **cladding assembly** comprising or including

a substrate (clad or otherwise)of a structure,

a plurality of fixing members attaching into said structure, and

a membrane supported on said structure by said fixing members,

wherein said fixing members have not been or have been driven penetratively through said membrane

and wherein there has been a fusion or other association of at least part of the membrane material(s) with at least part of the fixing members, or at least some of them, as a consequence of energy supplied through the membrane,

Preferably said energy has been applied as ultrasound.

Preferably said energy has been applied as heat.

In yet a further aspect still the present invention consists in a **weather resistant building envelope** wherein the weather resistance has been bestowed by a method as herein described.

In yet a further aspect still the present invention consists in a **in combination**, an ultrasonic device, and

a membrane, said device and said membrane being suitable for use in a method as claimed herein described.

Where herein the terms "fuse", "fusible" or "fusion" is used this is taken to mean the joining or ability to join of two or more materials, such that they at least in part melt or meld or intermingle to form a join, and such a join may be created by the application of heat (chemically induced or via conduction or convection or otherwise), ultrasound (e.g. welding) or solvent or similar methods.

Where herein the term "in situ" is used this is taken to mean in place whether in place upon the building structure or in place for pre-fabrication purposes prior to installation, i.e. that is, that, more or less the final disposition of the fixing members relative to the membrane is decided and they have been located, even if they have not as yet been driven into the building structure.

Where used herein the term "composite" is taken as meaning assembled, fabricated and/or coated so as to engender at least some fusible character to the fixing member.

To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments in accordance with the present invention will now be described where:

Figure 1 shows a plan and cross-sectional side elevation (along line A-A) of a fixing member to lie over the top of said cladding membrane,

Figure 2A shows a square form of the fixing member and cross-sectional view along line BB of Figure 1 and Figure 2B shows a penetrative fastening

which is used to fix the fixing member down onto the cladding membrane penetrating the cladding membrane and attaching to the envelope or building structure underneath,

Figure 3 shows a plan and cross-sectional side elevation (along line CC) of a fixing member to lie underneath the cladding membrane for the cladding membrane to be fusibly welded to,

Figure 4A shows a square form fixing member and cross-sectional view along D-D, similar to that of Figure 3 but which lies underneath the cladding, and Figure 4B shows a penetrative fastener to fasten the fixing member to the building envelope or substrate,

Figure 5 shows a, in end elevation, jointer for two abutting membranes to deform a tee joint, the jointer to lie over the top on the external surface of the cladding membrane, the joint is shown in cross-section being an extrusion, with optional fusible protrusions on its underside,

Figure 6 shows a further form of jointer, which is shown in horizontal cross-section, of an extrusion and has a joining part laid down over the top of the joint of two abutting membranes whereby a penetrative fastener passes through the jointer, a cap is laid on top of that and the jointer is fusibly welded to the two membranes underneath to form a weatherproof joint, shown with optional fusible protrusions on its undersides,

Figure 7 shows in **vertical** cross-section an extrusion of a jointer similar to that of Figure 5 but of greater width to be fusibly welded to the external surface of two abutting membranes, shown with optional fusible protrusions on its undersides,

Figure 8 shows in plan and in cross-section along line HH a jointer which is to be fastened by penetrative fastenings staggered along the length and width of the jointer through the jointer into the envelope or building structure, the cladding membranes then laid over the top to abut the tee portion of the jointer and thereafter fusibly welded to the joiner to form a weather proof joint, shown

with optional fusible protrusions on its topside to pin with the membrane underside.

Figure 9 shows in plan and in cross-section along line II a further form for a jointer which has a cap for location of the membrane to be jointed, the jointer laid onto the building structure or envelope and penetratively fastened thereto and thereafter the membranes to be jointed are laid onto the jointer under the cap and fusibly welded to form a weather proof seal,

Figure 10 shows a similar joint and cross-section to the of Figure 9 but with provision for fastenings through the sides and the middle,

Figure 11 shows the jointer of Figures 9 and/or 10 in plan and cross-section along line KK attached to the building substrate by a penetrative fasteners, the cladding membrane then laid onto the jointer and passed under the cap and thereafter fusibly welded to form a weather proof joint,

Figure 12 shows a corner fixing member similar in plan form to that shown in Figure 1 with the exception that it is cone shaped (to be shown later), whether flexible or rigid, having penetrative fastenings passing at least in part through the fixing member and through the membrane to be fixed in the corner and thereafter the fixing member fusibly welded to the cladding membrane to thus seal the corner and also hold the cladding membrane in place, the same component with reversed fastenings could be used on a ridge or protruding corner,

Figure 13 shows a similar view to that of Figure 12 with the exception that the fixed member (in broken line) lies underneath the cladding membrane and is penetratively fastened to the building substructure and thereafter the cladding membrane is fusibly welded to the fixing member, again the member may be flexible or rigid and may equally be used on a ridge or protruding corner with fastenings reversed.

Figure 14 shows an assembly of the cladding membrane fastened by either over or under fixing members, shown in Figures 1, 2, 3 and 4, to locate the cladding membrane onto the building substrate and also shows a strip jointer or

fixing as shown in any one of Figures 6, 8, 9, 10 or 11 and also a corner jointing member which has penetrative fastenings at least in part through itself and also through the cladding membrane to be held and thereafter the fixing member(s) is/are fusibly welded to the membrane underneath thus forming a weather tight corner seal and also holding the membrane in place, the same member can equally be used on a ridge with reversed fastenings,

Figure 15 is a similar view to that of Figure 14 showing another embodiment of the corner fixing member, again being able to be used on a ridge with reversed fastenings,

Figure 16 is a similar view to that of Figure 15 however the fixing member lies underneath the cladding member, is penetratively fixed to the building substructure, and thereafter the cladding membrane is fusibly welded to the fixing member to form a weather proof seal and also hold the cladding membrane in place,

Figure 17 shows in cross-section (along line Q-Q) and plan a fixing member for fixing and or sealing the cladding membrane in a corner situation,

Figure 18 shows a similar set of views to that of Figure 17 with the exception that the fixing member is of T shape for use in a corner and extension situation,

Figure 19 shows in side elevation and cross-section (along line SS) a strap like fixing member for external mounting over the cladding membrane with penetrative fastenings at least in part through the fixing member down through the cladding membrane which is thereafter fusibly welded to the cladding membrane to hold the cladding membrane in place, this fixing member may be used to seal a joint or merely to hold the cladding membrane in place,

Figure 20 shows a similar view of a strap like fixing member to that of Figure 19 with the exception that the fixing member lays underneath and fastened to the buildings substructure with the cladding member laid over the top and thereafter fusibly welded to the fixing member,

Figure 21 A (side elevation), B (plane elevation), C (sectional elevation along line UU) and D (isometric view) show various forms of a rigid corner member for sealing a corner of three surfaces to form a weatherproof corner seal,

Figure 22 A (side elevation), B (plane elevation), C (sectional elevation along line UU) and D (isometric view) shows various views of a circular corner jointer which is rigid which may be deformable under heat or cold forming to seal a corner or a circular corner of the cladding membrane,

Figure 23 A (side elevation), B (plane elevation), C (sectional view along line WW) and D (isometric view) shows various views of a further external rigid corner sealer similar to that shown of Figure 21,

Figure 24 views A (side elevation), B (plane elevation), C (sectional view along line XX) and D (isometric view) shows a similar circular sealing member to that of Figure 22 which the exception that it is flexible and has a different embodiment of cone structure for sealing a corner,

Figure 25 A (side elevation), B (plane elevation), C (sectional view along line YY) and D (isometric view) shows another variant of that of Figure 24 being a flexible corner sealer of differing angle again,

Figure 26 A and B shows in cross sectional vertical views a building substructure to which the cladding membrane has been attached and the various means by which the cladding membrane is attached to the substructure,

Figure 27 shows in vertical cross-section at (i) a two layer lamination consisting of A being the external layer and B being the second layer and at (ii) shows a three layer configuration of A external, B secondary and C tertiary layers and then at (iii) a three layer lamination consisting of A, B, C whereby B is encapsulated between A and C a single layer construction though not shown is also contemplated,

Figure 28 shows a machine in contact with the cladding membrane and fastener for fusing the two together, the machine also being usable to fuse the membrane to itself, and

Figure 29 shows a building structure with the cladding membrane applied.

DETAILED DESCRIPTION OF THE INVENTION

The form of the cladding membrane for a building system and its various lay-ups is summarised in Table 1 from the first layer being the top layer exposed to the environment the second layer and/or third optional layer successively. Figures 27(i), (ii) and (iii) show the options for lay-up being a two lay-up system consisting of a first layer 1 (also denoted by A in Table 1) the second layer laminated to the first layer 2 (also denoted by B in Table 1) and if used a third layer indicated by 3 (and also C in Table 2). The first layer 1 which is exposed to the environment consists of a layer of highly ultraviolet (UV) light stabilised thermoplastic polyurethane (TPU) of between 0.01mm to 5.0mm in thickness. Such stabilisation renders the TPU UV stable for in excess of 25 years. Preferably this first layer is in the range of 0.01mm to 1.5mm. This may be the only layer present for some embodiments however other embodiments go on to have second 2 and optionally third 3 laminates to the top layer.

A second laminate 2 (or B) may consist of an acrylonitrile butadiene styrene (ABS) of thickness between 0.001mm to 2.5mm. This may be the only other layer attached to the first layer although optionally there is a third layer that can be attached to a TPU-ABS lay-up being a further layer or third layer 3 (or C) of TPU of thickness between 0.01mm to 2.5mm, or an ABS layer of between 0.01mm to 2.5mm. When using a three layer laminate the middle layer 2 (or B) may be either continuous with the first 1 and third 3 layers or may be encapsulated by these two layers by sealing at the periphery of the sheet of cladding membrane to fully or partially encapsulate the second layer 2.

TABLE 1: Cladding Membrane Lay-up Options

First Layer	Second Layer (B)	Third Layer (Bottom)	Laminar/Encapsulated

(Top)(A)		(C)	
TPU (highly UV stabilised) 0.01mm – 5.0mm	ABS 0.001mm – 2.5mm	-	Laminar
		TPU 0.01mm – 2.5mm	Laminar or Encapsulated
		ABS 0.01mm – 2.5mm	Laminar or Encapsulated
	Aluminium Foil 0.001mm – 2.5mm	ABS/TPU/PP/PE//PC/EP DM/EVA 0.01mm – 2.5mm	Laminar or Encapsulated
	Aluminium Mesh 0.001mm – 2.5mm	ABS/TPU/PP/PE/PC/EP DM/EVA 0.01mm – 2.5mm	Laminar or Encapsulated
	Polypropylene 0.001mm – 2.5mm	ABS/TPU/PP/PE/PC/EP DM/EVA 0.01mm – 2.5mm	Laminar or Encapsulated
	Polycarbonate 0.001mm - 2.5mm	ABS/TPU/PP/PE/PC/EP DM/EVA 0.01mm – 2.5mm	Laminar or Encapsulated
	Polyethylene 0.001mm – 2.5mm	ABS/TPU/PP/PE/PC/EP DM/EVA 0.01mm – 2.5mm	Laminar or Encapsulated
	Natural Fibre (e.g. jute, cotton) 0.001mm – 2.5mm	ABS/TPU/PP/PE/PC/EP DM/EVA/TPR/PET 0.01mm – 2.5mm	Laminar or Encapsulated
	Man-made Fibre (e.g. PP, PET, PE) 0.001mm – 2.5mm	ABS/TPU/PP/PE/PC/EP DM/EVA/TPR/PET 0.01mm – 2.5mm	Laminar or Encapsulated

A differing second layer may be used consisting of aluminium foil or aluminium mesh whether partially or fully expanded, or able to be expanded, of thickness between 0.001mm to 2.5mm. The foil and in particular the mesh allows the resulting laid up membrane to be deformed and the resilient nature of the aluminium retains that defamation of the membrane. This allows better contouring to roofs or substrates to be clad where contouring or contour following of the substrate by the member is important. If the mesh is partially expanded then the defamation of the membrane into or over various contours is afforded by the meshes ability to further expand to follow the contour.

In such a lay-up an optional third layer 3 may be of Acrylonitrile-Butadiene-Styrene (ABS) or Thermoplastic Polyurethane (TPU) or Polypropylene (PP) or Polyethylene (PE) or Polycarbonate (PC) or Ethylene Propylene Diene Monomer (EPDM) or Ethyl Vinyl Acetate (EVA) varying between 0.01mm to 2.5mm. A similar situation exists where the second layer of aluminium foil or expandable aluminium mesh may be continuously laminated with the first and third layers or may be encapsulated therein as above.

The second layer 2 may alternatively consist of a layer of polypropylene or polycarbonate of between 0.001mm to 2.5mm and thereafter may have a third optional layer 3 laminated therewith consisting of ABS or TPU or PP or PE or EPDM or EVA of a thickness between 0.01mm to 2.5mm. Again the second layer 2 of polypropylene or polycarbonate may be fully laminar or encapsulated.

The second layer alternatively may consist of polyethylene between 0.001mm to 2.5mm and again may have an optional third layer of ABS or TPU or PP or PE or PC or EPDM or EVA of thickness between 0.01mm to 2.5mm laminated to form a three layer structure. Again the second layer 2 of polyethylene may be fully laminar or encapsulated by the first layer of TPU and the subsequent third layer.

The second layer again may alternatively consist of natural fibres or cloth such as jute, cotton or other naturally occurring fibres of between 0.001mm to 2.5mm laminated to a top layer 1 of thermoplastic polyurethane. Optionally a third layer may be laminated thereto consisting of ABS or TPU or PP or PE or EPDM or EVA or Thermo Plastic Rubber (TPR) or Polyethylene Tetraphthalate (PET) of a thickness between 0.01mm to 2.5mm. Again the second layer of natural fibre may be fully laminar or encapsulated by the first and third layers.

The second layer again may alternatively consist of a manmade fibre such as but not limited to PP or PET or PE or PC of a thickness between 0.001mm to 2.5mm which may be of woven, non-woven, melt blown or filament form. Optionally a third layer may thus be laminated to the second layer consisting of ABS or TPU or PP or PE or PC or EPD or EVA or TPR or PET of

a thickness between 0.01mm to 2.5mm. Again layer 2 manmade fibre may be fully laminar or encapsulated by layers 1 and 3. Other lay ups of differing plastics or metallic materials are contemplated (whether of multiple laminates or not) and these combinations fall within the scope of the invention.

Other lay ups may incorporate a mastic or adhesive or adhesive enabling or easily adhered material presently on the underside of the lay up for further fastening downward. An example of such a lay up is a mastic or adhesive which shows through an optional lower expanded aluminium mesh layer. These may be in substitution of either the second or third layer, or may be a fourth layer.

Second layers of ABS, plastic or aluminium based materials impart to the layup structure a toughness which is remarkable over existing materials used for such applications. This toughness combined with the environmental resistance and UV resistance of the thermoplastic polyurethane first layer make a cladding material which is very useful for the present situation. The presence of aluminium or metal based materials or deformable plastics also renders the cladding membrane to be shaped, whether hot or cold shaping occurs, to a permanent or semi-permanent desired shape, for example when bending around architraves, or other building structures to retain at least initially its desired shape prior to fastening. The use of natural or manmade fibres imparts a light yet tough material which is also suitable for at least cladding systems as described herein. The lamination of a thin first layer of thermoplastic polyurethane which is relatively expensive in comparison to other base materials such as ABS or the other mentioned plastics or metals allows a cost effective cladding membrane to be manufactured which is tough, yet cheap but which also has the required properties of weather and UV resistance whilst minimising the expensive material of the thermoplastic polyurethane. The lamination of this material with other base materials known in the art gives it further desirable properties. Other materials, which impart the above desired properties, known in the art are taken to be included in the scope of this invention.

With reference to Figures 1 through 26 there is shown the various components, layups and methodologies for constructing a cladding system in accordance with the present invention. The planar substrate 4 of the building such as ply wood or other cladding material is attached to a framing substrate 5 forming the skeleton and the planar substrate for framing the building substrate. The cladding membrane 6 together with fixing members and jointers forms the skin of the building and may be laid on vertical, horizontal or other surfaces as required. Of course in some situations where no load is to be taken either the framing substrate 5 or the planar substrate 4 may be omitted provided there is at least some form of substrate which the cladding membrane 6 can be applied to.

As referred to herein the terms building envelope, building substrate and, building substructure mean the underlying framing or planer (or otherwise) substrate of the building to which the cladding membrane 6 is attached to, unless specified otherwise.

Once the building substrate (either planar or framing) has been constructed then the cladding membrane may be applied. Two situations arise and these are whether the fixing members are to lie under the cladding membrane and thus against the building substrate or lie above the cladding membrane 6 and thus lie on top of the cladding membrane. A feature common to both types of fixing member is penetrative fastenings which allow the attachment or fastening of the fixing member to the building substrate. Alternatively there may be for the fastenings which lie against the building substrate another method of attachment such as adhesive or other means of adhering. The fixing members usually consist of a more rigid core such as that of a plastics or metal material about which is substantially coated a fusible weldable material such as thermoplastic polyurethane which is fusibly weldable by application of ultrasonic energy or thermal energy. The fixing member may also be purely of thermoplastic polyurethane rather than an over coating of a core. For discrete fastenings such as those shown in Figures 1 through 4 there is a singular location for a penetrative fastening, in this case, in the centre of the discrete fixing. The upper surface 9 of

the discrete fastenings 8 can also be sealed over to present a continuous sealed face. This becomes obviously advantageous when the discrete fixings of Figures 1 and 2 are used on the outer surface or upper surface of the cladding membrane.

The discrete fixings used for under surface fixing of the cladding membrane such as those shown in Figures 3 and 4 need not have such sealing over of the penetrative fastener on the upper surface 9 but may of course have this if so desired. The common characteristic of fixing members which lie on the upper surface of the cladding membrane is that their under surface 10 has at least a layer of fusibly weldable material, such as a thermoplastic polyurethane, so that when the fastener is in place it may be fusibly welded by ultrasonic or thermal or other means to the upper surface of the cladding membrane which also has a fusibly weldable material such as a thermoplastic polyurethane. A common characteristic of those fastenings which lie under the cladding membrane such as the discrete fastenings of Figures 3 and 4 is that the upper surface 9 has at least a layer of thermally fusible material such as a thermoplastic polyurethane which may be fusibly welded to a like under surface of the cladding membrane once it is laid over the top.

For both fixing members and jointers or joining components, or any area where fusible welding is to occur there may be optionally additionally protrusions 34 to direct the welding energy and provide a fusible region. These may take form of teeth, rounded bumps, concentric rings etc and may lie over the entire or only part of the member, membrane or jointer.

A join may also be effected by layering above and/or below the cladding membrane a further layer(s) of cladding membrane which are then fused together to create a join. Lap joins of abutting overlapping sheets are also envisaged.

Further embodiments of fixing members are shown in Figure 11 which is an extrusion preferably with a stiff core 35 and an outer coating 36 at least of a fusibly weldable material which has a cap 13 collected by an upright 14 which in this case also has a penetrative fastening 7 passing therethrough to form a lateral cavity 15 which allows the jointing of cladding membranes 6 to form a sealed

join once at least the membrane 6 is passed under the cap 13, and the cap 13 has been fusibly welded to the cladding membranes 6. The penetrative fastenings of such a fixing member may be as shown staggered diagonally across the width of the fixing member or may be disposed purely to one or other sides or purely in the middle. Means to form purely a sealing or join of two abutting sheets of cladding membrane take the form of either a flat strip which may be laid down over the join and then fusibly welded thereto or may be similar to that shown in Figures 5 and 7 whereby a tee jointer 21 may be laid over the join and the upright of the tee 22 lie in a space between the two membranes and the arms 16 of the tee lie over the upper surface of the cladding membranes to be joined. Thereafter fusible welding forms a permanent seal and join between the two cladding membranes and the jointer 21.

A contour strip jointer 18 which is similar to that shown in Figures 5 and 7 of a T jointer is shown in Figure 6 with provision for a penetrative fastening location 17 to allow the jointer 18 once laid over the two adjoining membranes to not only be fusibly welded to these membranes but also to fasten the membranes down by penetrative fastening. An engageable cap 19 may be disposed in a complimentary region 20 and may perform a seal mechanically or may form the seal by fusible welding. A similar T joint to that of Figures 6 and 7 is shown in Figure 8 with the exception that this is an invert tee which is fastened or fastenable to the building substrate and thereafter the cladding materials laid overtop with an upright ridge 23 running the length of the join and the cladding membrane being fusibly welded to the jointer to form a weather proof and element proof join. Again fastenings or fastening locations 7 are available for fixing the jointer to the building substrate prior to the cladding membranes being laid and sealed thereto.

Continuous strapping fixing members such as that shown in Figure 19 and 20 are also envisaged. The strap 24 shown in Figure 19 has at least an underside surface 10 which has a layer of thermally fusible material which when laid over the top of the cladding membrane can be fused thereto and with the

penetrative fastenings 7 passing through the strap 24 and the membrane and through into the building substrate will fasten the cladding membrane down. A further sealing membrane may be laid over the top of the strap 24 extending either side of the strap which then may also be fusibly welded down to either the strap or the cladding membrane to form a sealed fixing. Alternatively some form of mastic or silicon or similar may be used to fill in the fastening holes.

Figure 20 shows a strap similar to that of Figure 19 as 25 however this strap is designed to lie under the cladding membrane and thus will be fastened first via fasteners 7 into the building substrate and thereafter the cladding membrane is laid overtop of the strap 25 and then fusibly welded down by application of ultrasonic energy or thermal energy to permanently fuse the cladding membrane down to the strap. Of course in both embodiments 24 and 25 those surfaces to be fusibly welded have a suitable material that can be fusibly welded to the cladding membrane.

In corners consisting of two or three surfaces there exists the problem of sealing the join, if present, of the cladding membrane and also or additionally fastening that location to the building substrate. Shown in Figures 12 and 13 is one method of fastening the membrane down by having an overtop fastening member 26 laid into the, in this case, three surface corner which has penetrative fastening 7 to pass through the cladding membrane 6 and into the building substrate which is then fusibly welded to the upper surface of the cladding membrane 6. The overtop fastening member 26 having on its underside a thermally fusible material, and likewise the upper surface of the cladding membrane 6 has similar fusible material. Figure 13 shows a similar system to that of Figure 12 however the fastening member 27 lies under the cladding membranes 6 and has penetrative fastenings which are applied on or through the fastening 27 into the building substrate thereafter the cladding membrane 6 is laid over the top and the fastening member 27 is fusibly welded to the underside of the cladding membrane. Again surfaces to be thermally fused have thermally fusible materials present thereon. Corner pieces consisting of two or more

surfaces at an angle to each other are shown in Figures 14 and 15. These, as do previous joinings or fastening members, have a rigid core to which is over applied a layer of fusibly weldable material. The three surface jointer 28 has penetrative fastenings in or on thereto and lies on the upper surface of the cladding membrane 6 and is fastened into place and thereafter fusibly welded to the cladding material. At the lower portion 29 of the three surface jointer may be fastened down either by penetrative fastenings and or fusibly weldable fastenings to a substrate or a strap fixing member 25 to hold the lower surface 29 in place. Additionally the cladding membrane may lie overtop of lower surface 29 and be fusibly welded thereto. Likewise in Figure 15 a similar surface jointer is shown which is penetratively fastened to the building substrate lies over the top of the cladding membrane 6 and is fusibly welded thereto. An alternative embodiment to those of Figures 14 and 15 is shown in that of Figure 16 whereby the surface jointer 30 lies underneath the cladding material 6 is penetratively fastened to the building substrate and thereafter the cladding material 6 is fusibly welded to the surface jointer 30. The internal (inwards) corner pieces shown in Figures 12 through 16 can also be used on external (outwards) corners and ridges to seal and fasten and join, where penetrative fastenings are used these are reversed in direction to enable penetrative fastening. For example of this the corner inward overlap fastening member 26 may be used on an external corner in an overtop fashion but with fasteners 7 in the opposite direction. Members may further be flexible or rigid. Further embodiments of jointers are shown in Figures 17 and 18 for angled corners and tee joints. In Figures 21 through 25 are shown further embodiments of corner sealers. A sloping three surface jointer 31 is shown of a rigid variety (i.e. having a rigid core or base overlaid therewith a fusibly weldable material such as thermoplastic polyurethane) which is locatable in a matching corner over the top of or underneath of cladding membranes to be corner sealed. The sealing being achieved by fusibly weldable means such as ultrasonic welding or thermal welding. It is to be understood that those portions to be fusibly welded have like matching fusibly weldable materials. Variations

of a cone corner jointer both rigid and flexible are shown having differing angles or focus points to allow for varying shaped corners. The flexible and/or rigid corner is pushed into location at the corner to be joined or sealed and deformed into the corner to be sealed or joined (likewise for a ridge or external corner). The cone corner jointers may lie under or over the cladding membrane to be joined and a range of focus points or angles are available to fit the corner to be jointed as required.

A further embodiment of the three surface jointer of 31 as shown in Figure 23 as 32 and may again be rigid or flexible to under or overly the cladding material to be sealed or joined. The surface jointer being attached to the cladding membrane and sealing it by the application of energy to fusibly weld materials together.

Shown in Figure 26 is also a flashing cap 33 which has a layer of fusibly weldable material such as thermoplastic polyurethane on at least its outer an preferably its inner surfaces for fusible welding to a cladding membrane 6 to hold the cladding membrane in place and also seal thereto and also to hold the flashing cap 33 in place.

For any of the external or over surface fixing members described herein a further sealing member may be applied over the top such as a circle for those embodiments in Figures 1 or square for Figure 2 or whatever shape is required to extend past the periphery of the fixing member which can then be fusibly welded to the cladding membrane. Thus in a situation where the core of an over top fixing member is of metallic compound or compound that is not resistant to UV elements this fastening may nevertheless be rendered environmentally resistant and further sealed, particularly when the penetrative fastening shows through the top of the fixing member.

Various patterns may be used to achieve the fusible welding via ultrasonic or thermal means such as concentric circles or stippling of such a close nature that an impenetrable seal is formed particularly for external over top fixing and sealing members. These welding patterns may be matched to the form

of protrusions 34 at the welding site. In a situation where an over top fixing member is used and the penetrative fastening is left bear the underside of the penetrative fastening may have applied thereto a fusibly weldable material which will mate with a fusibly weldable material on the upper surface of the fixing member such that when ultrasonic or thermal energy is applied to that region a seal is formed between the penetrative fastener and the fixing member thus forming another way of creating a sealed fixing member. As referred to herein a fusibly weldable material that is exposed to the environment is of a thermoplastic polyurethane preferably. For underside or non exposed areas which require a fusibly weldable material either a thinner or cheaper layer of thermoplastic polyurethane may be used or other materials which are fusibly weldable may be used which are in themselves not necessarily UV stable or environmentally resistant as they are not exposed to the elements. In addition to the fastening methods detailed herein further retention of the cladding membrane to a building structure may be achieved by use of ballasted rooting methods whereby a stone or similar course is laid over the surface to retain by weight the cladding material onto the building structure. The cladding membrane may of course be applied to horizontal or vertical surfaces or the like and the fixing methods described herein will achieve such result. In preparing such a cladding system for example in a roof, an array of fastening members is fixed down to the building substructure thereafter the cladding membrane is laid over the top jointers are located in place whether above or below and the resulting structure is sealed by ultrasonic or thermal welding at the regions of the fasteners and also the joins and also any corners. If over the top fixing members are to be used then the cladding membrane is laid down over the building substructure the fixing members are penetratively fastened down through the cladding membrane to the building substructure and thereafter fusibly welded by ultrasonic or thermal and the jointers are laid down in place and thereafter the jointers and fixing members are fusibly welded to the cladding membrane to form a sealed weather proof structure.

The fixing members, jointers, and joining members and corners may be formed by extrusion, co-extrusion, lamination, over coating, moulding, moulding and over coating or other combination of these and other methods, known in the art. The cladding membrane likewise may be manufactured by extrusion, co-extrusion, lamination, moulding or coating or combination of these techniques and others known in the art.

The flashing cap 33 may likewise be manufactured, for example by co-extrusion or extrusion and over coating with thermoplastic polyurethane to form a flashing or structural element for windows and roofs with at least an external over coating of thermoplastic polyurethane. The base extrusion may be polypropylene or polyethylene, or aluminium or other suitable rigid material.

A fusing machine 38 is shown in Figure 28 applied to a capping of Figure 11. The machine 38, having an ultrasonic oscillator or thermal device or other fusing device to fuse the membrane 6 to the fastening or fixing member 26, 8.